National Aeronautics and
Space Administration

Ames Research Center
Moffett Field, CA 94035-1000

Reply to Attn of: TS:230/2 April 13, 2006

TO: Software of the Year Committee

FROM: James Reuther, CEV TPS-ADP Project Manager

SUBJECT: Statement in Support of DPLR for Software of the Year Award

The DPLR computational fluid dynamics (CFD) code is highly recommended for software of the year. While in the present day there are a large number of both commercial and government CFD software packages, unique capabilities of DPLR have recently proven to be critical to NASA. Unlike most CFD codes DPLR as the ability to accurately and efficiently compute real-gas Navier-Stokes solutions required to model the aerodynamics and aerothermodynamics of atmospheric entry.

During the difficult period of time after the Space Shuttle Columbia accident, the agency's re-entry experts came to the realization that an entirely new approach to assessing the health of the Orbiter's thermal protection system (TPS) was needed. The engineering correlation models used during the Columbia mission were woefully inadequate to deal with the realities of the damage that could occur to the Shuttle's fragile TPS. Meanwhile, the DPLR CFD code which was relatively new at the time, which was shown to be able to predict the surface heating for Shuttle during atmospheric entry, had never been used in real time during a NASA space mission, and had also never been used for the prediction of augmented heating due to damage. However, given the critical need and the rapid advances in both technology such as the DPLR and the availability of expanding super computer power, an attempt was required to create a real time CFD based Shuttle damage assessment capability. At the time, I was the agency's lead for computational aerothermal sub-team both for the Columbia accident investigation (CAIB) and the follow on Return to Flight (RTF) activities. In this role, I lead the agency in bringing forward and maturing CFD based capabilities to be able to assess any type of Orbiter damage in terms of atmospheric heating. By the time STS-114 took place aerothermal analysts at Ames, Johnson and Langley were ready. We were all hoping that Discovery's first flight would be problem free with no damage observed during her trip to Orbit. While we were ready with computer resources, DPLR, other software packages and the agency's best people, no one wanted to have to resort to using this newly established capability. Unfortunately, tile damage, blanket damage and tile gap filler protrusion were discovered in high resolution on Orbit images. In less than 8 hours after the damage was characterized, the NASA team using DPLR was able to put a large set of high fidelity CFD predictions of atmospheric heating due to tile damage in front of the mission managers to help them determine the safety of Discovery's mission. The tile damage was shown to not be a hazard from a variety of perspectives including DPLR. The tile gap filler protrusions proved otherwise. In combination with two other methods the DPLR CFD code was used to establish that the threat of over heating the delicate RCC wing leading edges due to turbulent flow cause by the gap filler protrusions was not just a remote possibility but instead a real threat. Engineers at the time agonized about the decision, but in the end, due in significant part to clear evidence provided by DPLR, the decision was made to send the astronauts out to remove the offending gap fillers.

Subsequent to STS-114, I transitioned from being the computational aerothermal lead for RTF to a core team member of the Exploration System Architecture Study (ESAS). Little did I know that DPLR would follow there. As the study matured and the general outlines of the Crew Exploration Vehicle (CEV) began to take shape, key decisions with respect to the vehicle were hinging on details of the vehicle shape and the heating it would need to endure. As a result, DPLR and the team at Ames were again called upon to rapidly assess the trade space in terms of heating and vehicle shape. Because ESAS was only a 60-day study the results of these trade studies were needed in near real time. Fortunately the preparedness for RTF was at hand and a very large number of DPLR calculations were carried out to complete the necessary trade studies in time. These successful trades allowed the final details of the CEV vehicle to close and result in the agency moving forward in its quest to enter the next phase of human space exploration.

The rapid and accurate analytical powers of DPLR have in two occasions during the last year been not simply helpful to have instead been critical to NASA's success. As a result DPLR remains ready if called upon again during subsequent Shuttle missions and has found a place in establishing the detailed aerothermal database for CEV. Thus it is my pleasure to strongly recommend DPLR for software of the year award.

James Reuther Ph.D.

Former Computational Aerothermal sub-team lead RTF
Former ESAS core team member
Project Manager, CEV Thermal Protection System

Phone: (650) 604-1516
Cell: (415) 816-3725
Fax: (650) 604-0350

email: jreuther@mail.arc.nasa.gov
NASA Ames Research Center
Mail-Stop 230-2
Moffett Field, CA 94035